Datarase][

Datarase II

WALLING CO.

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CONTENTS

DATARASE II

The Walling Co. manufactured the original DATARASE for five years. This was a metal cased, plug in the wall unit that would erase two at a time but only 24 or 28 pin types. Because of the need to erase the new larger packages and the great variety of PLD types, we designed the DATARASE II.

The DATARASE II has a molded plastic case, will erase four chips at a time, and up to 40 pin packages. It uses a tubular lamp (G4T5), rather than the globular lamp of the original DATARASE but retains the fast erase time. Power is supplied by a wall plug AC adapter. Two models are available.

- DATARASE IIACT is AC only with an internal timer and a beeper that sounds for half the set time after the lamp has turned off.

- DATARASE IIAC is AC only without a timer.

The timer unit has a trimmer pot labeled "MIN." for minutes and can be adjusted with a small blade tool to set the exposure time from 2 to 8 minutes. The timer is reset each time the unit is turned on.

The unit has a slide cover over the erase "platform." This cover is provided with an interlock to prevent the unit from operating if the cover is open. The EPROMs to be erased are placed, window side down, on the platform, centering them laterally over the light access holes. The platform has a variety of steps to aid this centering operation for all the package types we know of. With the EPROMs in place, the cover is slid closed and should "snap" closed. Then the slide switch on the end is moved to "ON" and the unit will start. The green indicator in the "O" of the ON word should light up. This green light is generated by a fluorescent dye on the end of a light pipe that is exposed to the UV generated by the lamp. Thus it is indicating actual UV output.

The lamp can be turned off by either the slide switch or by opening the cover. Thus, both the slide switch ON and the cover closed are necessary for the lamp to turn on. It is possible to defeat the interlock but you are cautioned to not look directly at the UV source without eye protection. Ordinary plastic or glass eye shields will do.

The electronic circuitry that drives the lamp is a simple, current regulating, boost switcher. This provides high voltage for starting the lamp and the constant current which is necessary for mercury vapor lamp operation and for stable UV output level.

The four erase stations available do not have exactly the same intensity. This varies somewhat with the lamp but, in general, the end stations will have about 20% lower intensity than the middle two. In normal use it is not likely that you will be aware of this difference.

Erase time of EPROMs is quite variable and is primarily determined by the manufacturer. Most Japanese EPROMs, as well as those from Intel, reach complete erasure in 60-90 seconds. We consider safe erase to be double this "threshold" time. Thus we say the "The Datarase erases most EPROMs in 3 minutes." However, some manufacturers are making EPROMs that may take 10 minutes to threshold and thus should be erased for 20 minutes. We have only seen this "tough case" once but it can happen. Also, some of the new micro computer chips and EPLDs require erase times two and three times that of the normal EPROM. The only real way to know is to measure the time it takes to reach threshold erase for a given manufacturer and type, and double that. Although the power level of the lamp in the Datarase II is about half the lamp design value, fast erase is attained by placing the EPROM very close to the lamp surface.

EPROMs can be worn out in use and have a limited UV exposure life but this is several thousand times the normal erase time. For example, leaving an EPROM erasing over night should not hurt it but several doses like that could damage it.

EPROM failure from use or overheating (molten solder temperature) generally appears as a single bit or byte that will not erase. Most programmers check erasure before "write" so they just tell you if it is not erased. If your programmer has the capability you can check to see if it is a general failure to erase or just a few bits.

There are some EPROMs on the surplus market that are "pulls" but the seller may not tell you. These are salvaged from surplus PC cards and may be damaged by overheating in the process. Most people who do "pulls" have ways to do this that assure the package body will not get too hot and they do thorough checks of the chip. However, it is apparent that this is not always the case.

GUARANTEE

We have tried to create the ultimate personal UV eraser. We hope it will operate forever but we know there will be some problems. All our units are unconditionally guaranteed for six months. Beyond this time we will repair any unit for $9.50 plus $2.50 S&H. If you do have a problem we want to know as quickly as possible. Call us at 1-800-338-9813.

THE EPROM

The first memory devices for computers were bi-stable vacuum tube circuits known as 'flip flops' and sonic pulses circulating through a length of metal or a tube of mercury. The first memory device that stayed around awhile was the "core" memory. This used a little donut of ferrite that could be magnetically polarized by a pulse of current in a wire passing through its center. The problem with this was that you could only tell which way it was polarized by giving it another pulse big enough to change its polarization and thus erasing the stored data. These little donuts (cores) were woven into "mats" with three wires through each core, two for select and one to read the condition. Whenever you read out a bit, you had to rewrite it if you wanted it to still be there. In spite of this complexity core memories became the dominant form till the semiconductor memory replaced it in the early 70's. The first semiconductor memories were about like the vacuum tube type. A bunch of flip flops but made very small.

In rapid sequence Intel introduced the first SRAM (Static Random Access Memory) and the DRAM (Dynamic Random Access Memory) The DRAM accesses the same as the SRAM but has a simpler memory element. It operates by storing the data as a charge on a tiny capacitor. This allowed a smaller memory cell and thus a larger memory matrix for a given chip size but because of the small size of the storage capacitor, the memory had to be "refreshed" several hundred times a second. That is; whatever state it was in, it had to be rewritten to enhance that state. At first this seemed to many to be a precarious way to store data but the DRAM proved reliable and is now the most common memory element.

In 1972, very shortly after the introduction of the DRAM, Intel also developed the EPROM (Erasable Programmable Read Only Memory). This device uses a single MOS transistor as the memory element. It is equipped with a "floating gate" that controls whether it is conducting or not. This gate is like a little capacitor plate over the transistor that is completely surrounded by insulating oxide. Because there is normally no conductive path to it, a charge or voltage level will remain indefinitely. The trick is to have a connection when you want it (to write or erase) and have no connection for normal use. This is done by making the insulating oxide thin enough, and uniform enough in that thinness, that a higher than normal voltage applied will cause a nondestructive break down or leak that will change the voltage level of the floating gate. If it can be changed both ways it is called an EEPROM (Electrically Erasable PROM) but this proved very difficult and only recently have EEPROMs (or E^2PROM) become competitive. The single direction gate charge was easier and another way was found to reverse the effect; UV light.

The charge that could be put on the floating gate could be removed by exposing the transistor to 254 nm wavelength UV light. There is nothing magic about 254nm. It just happens to be the easiest wave length to produce with a mercury vapor lamp and conveniently is nearly absent from sunlight and common light sources.

Whenever light impinges on matter it has the potential of popping electrons loose from the surface. For a given element this takes a certain minimum frequency of light. Any frequency higher than that minimum will produce these "photo electrons" with proportionately higher velocities and the quantity will be proportional to the light intensity. If photo electrons can be produced in this gate structure of sufficient velocity (energy) they will penetrate the oxide insulation and deplete the charge. The structure is designed so that the convenient 254nm wave length of the mercury vapor lamp will do this. Of course this requires a window in the package to allow the light in and it means you have to erase the whole thing or nothing.

EPROMs have become one of the most widely used memory devices and are now available up to four million bits on a single chip. They are widely used as an economical way to prototype microcomputer chips by using an EPROM array instead of ROM. Also complex logic chips are being made with interconnects formed by EPROM memory element (EPLD) (Erasable Programmable Logic Device).

All of these EPROM devices will likely be replaced by EEPROM types eventually, as they become more cost effective, but, at the moment, the EPROM remains dominant.

SOLID STATE MEMORY
and
EPROM OPERATION

Static Random Access Memory (SRAM) or Dynamic RAM (DRAM) can be read or written at full computer speed but it does not retain the data after power is shut off. The EPROM (Erasable Programmable Read Only Memory) will retain data after power off and can be read at full computer speed but can only be written and erased slowly by special devices external to the computer. SRAM and DRAM developed as bit wide chips. That is; eight chips are generally required operating in parallel address mode to read out an eight bit byte. The EPROM, on the other hand, developed as a "Byte wide" chip. One set of address lines access one Byte (eight bits). Obviously this requires the EPROM chips to have at least seven more pins than the DRAMS. An even greater difference is that DRAMS are "multiplexed." A 256K DRAM must have eighteen binary coded address lines to select one memory location out of 262,144. To avoid the requirement for 18 address pins, nine pins are time shared with the first nine bits of the address, called ROW, applied during the first half of the memory cycle, and the second nine bits, called COLumn, applied during the second half. This time sharing is called multiplexing. The memory location cannot be accessed til all 18 bits of the address are present in the DRAM and then it takes some time for the logic to make the selection. The total time, from the start of application of ROW address til data just starts to be available at the data pins, is called the "Access time" (Even the slowest chips now have access time of 250 nano seconds). A little more time is needed for the data to stabilize and for the device designated to receive the data to capture it. The EPROM operates in much the same way but without the complexity of address multiplexing and the ganging of chips to get a Byte wide data output.

A 27256 EPROM has 262,144 bits of memory like the 256K DRAM but since it is organized as Byte wide data, there are only 256K/8 = 32K memory locations and only fifteen address lines are needed. With fifteen address lines and 8 data lines at least 23 pins are needed. Add power, and you have 25 pins. There are several other functions needed and these are cleverly combined in the remaining three pins of a 28 pin package.

One of these functions is to allow the Data lines to be used as both in and out. Another is to provide the higher programming voltage needed for writing to the EPROM. Since all memory devices in a system are tied to the same address and data lines, control functions are needed to allow the address information in (usually called "Chip Enable" or CE) and a means to make the data pins connect or not to the computer data lines (usually called "Output Enable or OE).

Originally the small capacity EPROMs had all these control functions on different pins. As more memory was provided on a chip and more address lines were needed, some of these control pins were required to serve multiple purposes.

Thus, in most EPROMs used now, the control functions are a complicated combination of voltage levels on these control pins. The 27256 for example has eight different operating modes all determined by the three control pins.

The EPROM started out in a 24 pin package, as originated by Intel. Some other manufacturers made EPROMs in packages of fewer pins but they have mostly vanished from use and the Intel standard is now almost universally used.

The first, the 2708, was 24 pin and, as mentioned, was a straight forward control method. The 2716 was next and the added address line meant complicating the control a little. The 2732 was still a 24 pin package and called for still more combined control pin action. With the 2764 the package size increased to 28 pins and simple control again. The 27128 had almost the same control functions but with the 27256 it got

complicated again. Each of these has a little different control method for programming, though the "Read" function is straight forward. Along with this development of larger size memory matrix, methods were found to reduce the programming voltage. It went from 25V on the early units to 21V and now to 12.5V.

As stated earlier, an EPROM is read at full computer speed much as any other memory device. Writing is quite a different situation. The EPROM data can only be changed from "1's" to "0's" by writing. "1" being a high output data line and "0" being a low. High is generally about 4V and low is less than .5V.

Writing an EPROM is slow compared to computer speeds. It requires applying programming voltage and data to the EPROM while the desired address is selected for as much as 50 milliseconds per Byte. This is about 200,000 times as long as it takes to read that Byte.

Actually, the way EPROM's are written is to apply these signals for about one millisecond. Then the mode is switched to "Verify" which allows read out without changing the programming voltage. If the data read out is not the same as that being written, the 1ms write cycle is repeated. This is continued till a proper verify is observed. At that point the EPROM writing program applies the programming data and address, as before, but for a period of time that is some function of the total time it took to get that Byte to absorb the data. For example, Intel suggests the final pulse should be three times as long as the total of all the pulses it took to get a good "Verify" response. This is to charge the floating gate well beyond a threshold condition.

The newer EPROMs have the capability of much faster writing. One method is to apply 6V to the Vcc pin (normally 5V) and to use 100microsecond programming pulses. This takes advantage of the fact that most Bytes write much faster than the worst case. Also, operating at Vcc = 6V during programming has something of the same effect as the final "over program" pulse of the other method. When the "Verify" is threshold at Vcc =6V it is well over threshold at Vcc = 5V.

As mentioned, the EPROM bits can only be written from "1" to "0". Thus, to write an EPROM it is generally necessary to restore the entire memory matrix to "1's" by ultra violet light erasure. If read out in Hex code, the Bytes appear as FF indicating all bits are "1's".

EPROM programmers have the means of applying the address and data codes to the EPROM and holding them there for the relatively long time necessary. They also have the means of applying the proper program voltage and control codes to suit the particular EPROM being used.

Normally a programmer provides:

Erase check: To check for full erasure.

Verify: To check the stored data.

Write: To store a block of data.

The "Write" function generally incorporates the first two also. That is; it will do an Erase check just prior to writing and abort if the EPROM is not blank. However, most programmers allow you to bypass this routine if desired so that just a portion of the EPROM can be written. Ordinarily, on completion of the "Write" cycle, the program does a "Verify" routine just to be sure it does read out properly. The Erase Check and Verify routines can take less than 10 milliseconds for a 256K EPROM so they are not noticeable relative to the minutes necessary for the "Write" cycle.

ULTRA VIOLET LIGHT

Ultra Violet (UV) is electromagnetic radiation, the same as visible light, infra red light and radio transmission. It is the light that is of higher frequency (shorter wave length) than the visible spectrum, but acts in many ways the same as visible light. It is refracted and reflected but, because it is different "color" than visible light, it does not penetrate and reflect the same as visible light. Actually the range of wave lengths we call Ultra Violet extends twenty times the range of visible wave lengths. Thus the behavior of some wave lengths of UV are very different from others just as red light is absorbed and reflected differently from green light.

Only those wave lengths of UV very close to the visible (400 to 200 nanometer) are of practical use since it is very difficult to find materials that will pass the shorter wave lengths. Visible light (700 - 400 nm) passes through those things we perceive as transparent such as glass and plastics, but these are increasingly opaque to UV as the wave length gets shorter. Water, quartz and some crystals pass UV quite well to 200 nm wave length but ordinary glass begins to attenuate at 400 nm and is quite opaque at 300 nm. Most "clear" plastics behave similarly.

UV light has long been most easily produced by the mercury vapor arc. A tiny bit of mercury metal in an evacuated tube equipped with electrodes in the ends is all that is basically needed for a mercury arc lamp. Usually a little argon gas is added to help get the arc started. When the tube is warm enough to provide a sufficient mercury vapor pressure, electric current can pass through the vapor causing light to be produced. Depending upon the current and pressure, the light emitted can be mostly UV or mostly visible. It so happens that the most efficient UV generation is at very low temperature and current. Mercury vapor, as does any ionized gas, emits light at very specific wave lengths that are called the spectra of the gas.

These narrow bands of emission are called the spectral lines and, to the trained observer, identify the element just like a fingerprint. The wave lengths of the lines are not shifted by changes of pressure or current but the amount of energy in each does change. That is; the energy distribution over the spectrum changes. Thus higher current produces more energy in the visible range.

All elements exhibit some few very dominant spectral lines though there may be hundreds of minor ones. With Mercury the dominant UV lines occur at 254nm and 360nm. Because Mercury vapor produces these wave lengths easily and efficiently these have become generally known as short and long wave UV. The long wave (360nm) type has for many years been used for suntan lamps and the illumination of fluorescent materials. The short wave will do the same but it burns more than tans and it is harmful to eyes. Also it is difficult to make tubes that will pass the short wave UV.

Very early in the experimentation with Mercury Vapor lamps it was discovered that at very low pressure and current almost all the electric power could be converted into the short wave line. In a practical lamp this can be 80 - 90%. However, to maintain this exceptional conversion efficiency the pressure, and consequently the lamp temperature, must be very low. About 130-140F. In the 1930's the effort to utilize this effect for visible light succeeded with the development of the now common fluorescent lamp. The lamps must be made very large for their power to keep the temperature low enough and the short wave UV inside is converted to visible light by a phosphor coating on the inside of the tube.

As you could expect, the problem of making a phosphor that would appear to produce white light and to do it with good efficiency was quite difficult. Also the phosphor coating had to be just thick enough to capture all the UV without impeding the passage of the visible light. The tubes themselves could then be made of ordinary glass that would not pass the short wave UV.

Through all this conversion process the resulting efficiency ends up at about 10-20% which is a great improvement over the 2-5% possible in the ordinary incandescent lamp. Over the years the colors have gotten better, the efficiencies have improved and the expected lamp life is now about 15,000 hours. Perhaps most remarkable, these lamps are now relatively cheap.

Even sun tan lamps are now made the same way as the visible light lamps by using phosphors that emit the desired longer wave length UV. This allows a closer approximation to the tanning rays of the sun.

Sunlight does not contain much of the short wave UV. At least it doesn't by the time it gets through our atmosphere. The sunlight spectrum has bright and dark lines but for the most part it is a continuous spectrum. Plants and human skin react to different parts of the spectrum in different ways. Thus, with fluorescent lamps it is possible to tailor the phosphor to emit mostly those bands of light desired for the purpose.

If the ordinary fluorescent lamp is made without a phosphor and the tube is made of quartz or a special borosilicate glass that will pass the short wave UV, it becomes a type useful for germicidal purposes, producing Ozone, or erasing EPROMs. However, even though the form and drive is the same, because of the greater difficulty in working the glass and the low production, these short wave UV lamps are relatively expensive.

This exceptional conversion efficiency, from electric current to 254nm UV light possible in the low pressure Mercury arc, happens in what is called the "resonance mode." 254nm light will not easily pass through Mercury vapor. It excites the atom which then "rings" or resonates at that frequency and a little bit at other frequencies so it uses up some of the energy. The result is that the only UV that can excite the phosphor or escape the lamp is that which is produced just at the inner surface of the tube.

One of these short wave UV lamps appears to be full of a blue fog when operating. Blue light is emitting throughout but the UV that is coming out is that which is produced just on the inner surface of the tube. Because of this, the surface UV intensity is the same for small or large lamps. Generally, a low pressure mercury arc lamp has a surface area directly proportional to it's wattage. This is necessary to maintain the temperature and in turn the mercury vapor pressure. If one is attempting to compute the UV intensity, and EPROM erase time at a lamp to EPROM distance of three feet, the lamp wattage is a prime factor. However, if the distance is about one inch, as is generally used, the lamp wattage is of little importance. The inverse square law is only valid relative to a point source.

In a large EPROM eraser that has a close packed set of UV tubes, it makes little difference whether the EPROM is one inch or three inch distance. However, in a small eraser, such as the Datarase II, the distance is a very important factor. Thus putting the EPROM within 1/8" of the lamp surface decreases erase time dramatically.

The low pressure Mercury vapor arc also has a spectral line at 185nm but this is even more difficult to pass thru the lamp envelope. Those types which pass it are generally identified by the prefix "OZ" for OZone producing. The Oxygen molecule, O_2, absorbs UV light of shorter wavelength than 190nm. When three O_2 molecules impact while energized by this light, they can convert to two Ozone, O_3, molecules. Ozone is an unstable form of Oxygen that will readily convert back to normal Oxygen if two O_3 molecules impact but not while energized by the UV light. Ozone absorbs UV of wavelength shorter than 290nm so it absorbs the same radiation that created it and more.

OZONE LAYER

Sunlight at very high altitude has enough of this <190nm UV to create Ozone. The air below thirty miles is dense enough to provide sufficient triple O_2 impacts to allow Ozone to be produced. Ozone is 50% heavier than air so it tends to sink to lower altitude. The Ozone cannot convert back to O_2 as long as it is energized by the UV, so it builds up, settles to lower altitude, and absorbs UV shorter than 290nm wavelength. When the Ozone layer becomes thick enough to have absorbed enough of the UV, the Ozone molecules at the lower side can convert back to normal Oxygen. Thus Ozone is constantly being generated on the top side and reverting to Oxygen on the bottom side. In the process of absorbing most of the short wave UV, the layer gets hot. It is actually 60-80°C higher temperature than the air ten miles above or below it.

Without sunlight UV the Ozone will slowly convert back to normal Oxygen as it does each year at the Earth's Poles after a winter of no sunlight. This is the so-called Ozone hole. This does not, of course, result in more UV reaching the surface of the Earth because the temporary Ozone reduction only happens because of the absence of UV.

It is apparent from this that the self limiting process called the Ozone layer has the potential of far more Ozone production than is currently the case. Thus any postulated Ozone eating nemesis, as is claimed of the CFC gasses, would have to be very effective to make a measurable change.

At sea level the current CFC density is said to be about one part per billion and may double in the next fifty years. The CFCs are 3-to 6 times as heavy as air. Thus, the likelihood of any meaningful CFC existence at thirty mile altitude seems slight. It is most likely that they just settle into the sand and dirt of the Earth and are cemented in place by the continuous deposit of dust and rain.

STATIC ELECTRICITY

With MOS (Metal-Oxide-Semiconductor) transistors, static electric discharge has become important. The low power operation of MOS devices brought with it great sensitivity to small electric charges. MOS IC's (Integrated Circuit) are equipped with protective circuitry on the input and output pins but these are necessarily limited in effectiveness to avoid degradation of the device response time.

The most likely cause of static electric damage to IC's is the discharge of the energy stored on a human body <u>THRU</u> the IC. In dry weather walking across a carpet can charge the body to several thousand volts. The energy level is directly proportional to the capacitance (surface area of the body) and to the square of the voltage. To cause physical damage to something this energy must be discharged quickly. When so charged, and we touch a light fixture or computer case, we can feel a little shock from the spark discharge. This happens in a few microseconds.

If the discharge means is a low conductivity material such as a glass, wooden or Phenolic table top, no shock is felt. Discharge does take place but in milliseconds instead of microseconds. If the object touched is a synthetic plastic such as Styrene, Nylon, ABS or Polyethylene, no spark results because the conductivity of the plastic is so low that little or no discharge takes place.

The surface area of an IC package is so small, the worst case charge that is likely to be picked up by a human body cannot transfer enough energy into it to damage it unless there is a current path THRU it. That is; if you are highly charged and you pick up an IC from a Styrene surface very little energy transfer takes place from body to IC. Conversely, if you pick up the IC from a metal surface, such as a computer case, there is a good chance that a conductive path may be created from your fingers on one end of the IC to the metal case on the other end. This can cause a large energy transfer thru the IC and can "Kill" it in a microsecond. If the surface is wood or Phenolic (such as Formica) the current can pass but it is too weak to damage the IC.

It is a good policy to always equalize voltage levels between people or objects when moving an IC. If someone hands you an IC, touch their finger with your finger before touching the IC. Similarly, develop the habit of always touching the surface of the object supporting the IC before picking it up or putting it down. The same applies to PC boards.

The Datarase II case is made of ABS plastic and has such low conductivity that static electric damage to an IC from placing or removing it is very unlikely. Even so, it is best to follow the finger touch rule. Better to zap your finger than your IC.

DATARASE II EMISSION LEVEL

The specified emission of the lamp used (G4T5) is 5.4 uW/cm^2 at one meter distance when operated with an inductor ballast at .162 Amps AC. By inverse square law, if this is extrapolated to a one inch distance, the emission level should be 8400 uW/cm^2 and this is claimed by some eraser manufacturers. But the inverse square law only applies to point source emission. The only way to be sure of the actual emission level is to compare the erase time for a given EPROM at a distant point, where the emission can be known with some certainty, with the erase time in the actual eraser.

A typical 2764 Hitachi EPROM that takes 52 minutes to erase at 12 inch distance with a lamp operating at the manufacturers specification, will erase in 78 seconds at one inch distance. This calculates to be a power level of 2365 uW/cm^2 at one inch distance. This EPROM will erase in 41 sec. in the Datarase II. This calculates to be an actual UV power level at the EPROM of 4500 uW/cm^2.

The actual input power to the lamp in the Datarase II is about half the lamp specification (2 watts rather than 4 watts) and it is direct current rather than the alternating pulses normally used. Because of this, the lamp life should be many times the 3000 hrs. specified with AC operation. We don't expect the Datarase II to ever require lamp replacement.

The original Intel specification for EPROM erasure was 15$Wsec/cm^2$. To achieve this from a 4500uW/cm^2 source would require an exposure of 55 minutes. Obviously EPROM erasure times have improved greatly from the original yet most manufacturers still call out the original spec. Maximum exposure is stated to be the equivalent of about three weeks in the Datarase II (7200$Wsec/cm^2$) so long exposures are not likely to be harmful.